AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 9, Vol. IX. New Series.] NOVEMBER 1, 1842. [Whole No. 416 Vol. XV.

CANALS OF CANADA; THEIR PROSPECTS AND PROBABLE INFLUENCE ON THE COUNTRY. *By* W. R. CASEY, *Civil Engineer.*

An account of the great public works now in progress in Canada will probably have some interest for most of the readers of the Journal.

Many of the newspapers are bringing forward these "ship canals" as rivals likely to sweep away the western trade from the Erie canal; because they are 8 or 10 times larger, avoiding all allusion to their cost increasing in the same ratio, or very nearly so. They also do not inform us how the main consumers of the produce of the west—the people of New York, New England, New Jersey, the Army, Navy, commercial marine, etc.—are to receive their supplies via the St. Lawrence; and, although exaggerating the really great advantages of that route as far as tide-water, say not a word of the immense superiority of New York as a port of shipment, open throughout the year, and with rates of freight scarcely half those from Montreal to England. The average difference is from 2*s.* to 2*s.* 6*d.* stg. per barrel of flour, though the last Montreal quotations were 6*s.* sterling to "London, Liverpool and the Clyde," the New York rates being at the same time, 1*s.* 6*d.* sterling. Now the average rates from Lake Ontario to Montreal, are 1*s.* 6*d.* sterling, per barrel of flour, which is only two-thirds the difference in

favor of New York; so, that were flour carried for nothing from Kingston or Ontario to Montreal, that city would still be unable to compete with New York on equal terms. Western flour is delivered at Montreal for about 10*d.* sterling per barrel less than at New York, but the natural advantages of New York, as a port of export, more than counterbalance the advantages which Montreal derives from the downward navigation of the St. Lawrence; and, but for the English corn laws, the western trade of Lower Canada would be limited to the quantity required for home consumption.*

That portion of the western trade which seeks a foreign market via the St. Lawrence, is attracted by political rather than national or engineering advantages, and, to this extent, does not come within the province of this Journal. The works now in progress, however, are to reduce the cost of transportation from Ontario to Montreal, and, as this is the highest engineering consideration involved in their projection, its discussion in these pages is anything but out of place.

It may be well to glance at the Welland Canal—the feeder of the St. Lawrence canals. The locks of this canal were originally of wood, but the Canadian government is now replacing them with locks of stone, 120 feet long 26 feet wide, and 8½ feet water on the sill, which will easily pass lake craft of 150 tons burden. The original cost was £491,777 currency ($4 to the pound) and the sum required for its completion, is estimated at £450,000—say 4 millions of dollars on about 36 miles of canal, requiring an income of $240,000 to clear expenses and 5 per cent. interest. It is said that the income this year will reach $100,000, and the writer believes it will eventually cease to be a burden on the Province, from the very peculiar advantages it possesses over every route which can be projected in the state of New York for the trade of Lake Erie; which advantages are given at length, in an article on the "spring trade," in this Journal of 15th April last.

Steamboats have for many years descended the St. Lawrence about 100 miles below Kingston, where the first canal begins. This branch is called the Cornwall canal, and is just opened. It is 11¼ miles long, 140 feet wide by 10 feet deep, locks 200 feet long in the chamber, 55 feet wide and 9 feet water on the sill. Lockage 48 feet, cost $1,600,000 without any protection to inner slopes.

* Competition on equal terms with New York is generally considered impracticable in Canada, though it appears to the writer, that, by carrying western produce to Quebec in the St. Lawrence barges and transhipping there, some saving might be effected.

This work reaches from the head of the "Long Sault" to "Lake St. Francis," as the next 40 miles of the river are called. At the foot of this lake commence the "Coteau" rapids, then the "Cedars" and the "Cascades," in which distance—15 miles—the St. Lawrence falls 82 feet, expanding again into "Lake St. Louis." These rapids are to be surmounted by the "Beauharnois canal," commenced last summer; 120 feet wide, 10 feet deep, locks 200 by 45. *Estimated* cost £255,900 ($1,023,600.)

Lake St. Louis is about 24 miles long and is connected with the port of Montreal by the Lachine Canal, around the Lachine rapids, which has been in operation many years. It is 9 miles long, lock 100 by 30 with 5 feet water on the sill. Lockage about 40 feet. This canal varies much in width and depth like the Erie canal. Its enlargement has just been commenced.

The distance (by steamboats and stages,) is estimated at 180 miles, of which about 105 miles are still-water, 40 miles strong current though navigable, and about 35 miles are rapids, the river falling about 170 feet in that distance, though not uniformly, about 100 feet occurring in less than 10 miles.

Lake Ontario and Montreal are also connected by the "Rideau," a military work, which is used for the ascending trade. Distance by this route about 240 miles.

The down-trade is by the river, about 200 miles, barges and small steamers running direct from Kingston to Montreal. The draft of water is limited by the depth in the "Cedars," where, at lowest water, a vessel cannot pass, drawing more than 4 feet, to 4 feet two inches. It must be observed that nothing has ever been done to improve the down-trade of the St. Lawrence, and, the writer believes, that a sum not exceeding £20,000 cy. would give 5 feet water at lowest water in the Cedars, besides less important improvements, such as removing boulders, placing buoys, etc., at other places. In the spring of 1841, a large steamer from Ontario passed over all the rapids for the first time. Previous to this the trade had always used the Lachine canal both ways, but, during the past summer, the leading forwarders sent their barges and steamers over the Lachine rapids; their example was followed by others, and, finally, the Insurance Companies were forced to include *these* rapids in their policies.

These little steamers are only 20 feet beam—some with paddle-wheels, others with propellers—and take both passengers and freight. The barges carry from 1000 to 1400 barrels of flour, and,

with the trifling improvement above spoken of, would average about 1500 barrels. The charges may be taken, throughout the season, at 35 cents, (1*s.* 9*d.* cy.) per barrel of flour—insurance about 2 cents per barrel. The up-freight is comparatively small in amount, as the merchandize, consumed by the farmers who produce the flour, etc., which descends the St. Lawrence, reaches them through the Erie canal. Notwithstanding this, the charges from Montreal to Kingston differ little from those up the Erie canal.

Now the grand question is, how much will the canal reduce the cost of transportation—more especially on the down-freight, which is indeed the only *great* consideration; for, if the western states are to receive their merchandize via the St. Lawrence, this up-freight will be regulated entirely by the down-trade, if, as at present, via the Erie Canal, the down-trade becomes the *only* consideration.

The proportions of the locks show that these canals are to be navigated by large steamers, the Welland canal is a schooner canal, hence the success of the work rests on the difference in cost of freight from Kingston to Montreal, in steamboats, as compared with the present mode by barges; transhipment being of course necessary in both cases at Kingston. The lake schooners may go to Montreal, but, as they only require locks 26 feet wide, it is clear that the projectors of these canals looked *principally* to steamboats to warrant the enormous difference in cost.

The government of Canada, like that of New York, proposes no reduction of tolls in consequence of enlargements. The tolls of the Lachine canal are 2*d.* cy.=$3\frac{1}{3}$ cents per barrel of flour for 9 miles, the boat pays $4, the hauling costs $2 50; in all $39.83 per 1000 barrels for 9 miles = very nearly 4 cents per barrel. Steamboats do not require towing, hence the cost by canal will be $2,-50 less = $37.33 per 1000 barrels, supposing the steamer to pay nothing additional on account of injury to banks, lock gates, etc. Assuming the tolls on the great canals to be no higher than on the old Lachine canal, we have for 36 miles of canal 15 cents, (14.932) or 9*d.* cy. per barrel for these charges alone, leaving the forwarder only 20 cents per barrel for 180 miles, on which sum the saving—if any—must be effected.

We may safely take the rate from Albany to New York by the Hudson, as the lowest possible, because—the navigation is scarcely equalled—a single steamer tows 3 or 4 barges of from 200 to 500 tons each, and frequently a dozen canal boats besides—the compe-

tition is great—they have the advantages of many years experience—the navigation is open during 8 1-2 to 9 months in the year —the up-freight is large and the number of emigrants also great. The charge is still 12 1-2 cents per barrel of flour carried 150 miles = 15 cents (9*d*. cy.) per barrel, for 180 miles, carried in barges towed by steamers under the most favorable circumstances. But if the freight be carried *in* the steamers—if the up-freight be trifling—if the navigation be far inferior, 36 miles indeed of strong current bordering occasionally on rapids—if the season be shorter and the total amount of business not to be mentioned with that of the Hudson—it will at least not be allowing *too much* to add one third for the same duty on the St. Lawrence which gives 20 cents (1*s*. cy.) as the minimum probable, or rather possible cost per barrel of flour, carried from Kingston to Montreal, in large steamers, via the St. Lawrence canals, exclusive of tolls.* These are, even on the present Lachine canal, at the rate of 15 cents, (9*d*. cy.) and that the enormous sum to be laid out on its enlargement—estimated at $100,000 per mile—is to reduce these tolls, will be asserted by no man of ordinary intelligence or integrity.

All the pilotage and the greater part of the insurance will be saved, by using the canals; the former is $8 per barge and two thirds of the latter 1 1-3 cents = $21.33 per 1000 barrels against $149.-32 by the canals. The latter could be used when gales or head winds would render the rapids impracticable to barges without steam—on the other hand, the saving of time by the rapids would *generally* be about 12 hours, and they can be navigated earlier and later than the canals, as is only too well known in Montreal, so that the river has the advantage of the canals even in these minor considerations.

But if an additional foot of water can be had in the "Cedars," 1500 barrels will be the average load of the present barges with no other cost to the forwarder than insurance and handling, about 5 cents per barrel, and thus enable him to carry from 27 to 28 cents per barrel or even 25 cents in iron barges. The introduction of such vessels, with the improvements already mentioned, would, in the opinion of the writer, do all that is practicable or even desirable towards giving facilities to a downward trade per day equal to that of the Erie canal per year. Taking every thing in the most

* Flour was carried during the past season from Montreal to Quebec for 5d. cy. per barrel, equal 6 1-3 cents, also from Kingston to Montreal for 25 cents, but at a loss in both cases.

favorable light, it appears at least, barely possible, that the contemplated plan of carrying freight in steamboats, should be equal in economy to the present mode of transportation without any other than the natural advantages of the St. Lawrence.

It will be said that barges may be towed on the St. Lawrence as on the Hudson. But why then build steamboat canals at 7 times the cost and with 3 times the tolls of a canal for barges, when the tolls on the steamer alone must be more than the cost of towing the barges by horses. If barges are to be used, all acquainted with inland navigation know, that towing by steamers on natural waters, and by horse power on canals are the cheapest modes of effecting such transportation yet devised.

The good people of Canada have also been entertained with the idea of ships from the ocean taking in cargos at Cleveland and Chicago; but as this journal is not devoted to romance or politics, it is unnecessary to allude to it further than to say, that the same story is now used as a bugbear to frighten the people of New York into a continuance of their insane expenditure; as the enlargement of the Erie canal—now indefinitely postponed—has been used for a similar purpose in Canada. Lake schooners may be taken by the canals to Montreal and thus may transhipment at Kingston be avoided. These vessels *must* go through the canals and pay the tolls which the barges avoid, the capital invested in the same tonage is three times as great, they are much heavier and more difficult and expensive to handle, they will be towed with difficulty above the Long Sault, which objections united and properly estimated could not be less than six times the mere cost of transhipment.

Lastly, there is to be considered, what dimension of barges will carry at the minimum cost. Judging from the coasting trade of all countries, where almost any depth of water may be had as well as full loads, also from the great lakes, it will be found that the average will not exceed 150 tons burden. But, in the present case, there is another element—the cost of the canal—which again should be determined from the present and probable future business within a reasonable period. About 700,000 tons (exclusive of stone, lime, clay, etc. for the enlargement, but including 150,000 tons lumber) pass annually over the Erie canal, of which about 140,000 tons are up-freight. Now it will be looking as far ahead as any man, not ship canal mad, can desire, to assume the up-freight of the St. Lawrence at 70,000 tons per annum. The tolls on merchandize on the Erie canal are 9 mills per 1000 pounds per mile

=2 cents per ton of 2240 pounds, very nearly = for 36 miles $50,400 (£12,600 cy.) for up-freight. Repairs, superintendance and renewals cannot well be estimated at less than $30,000, leaving only $20,000 = at 4 per cent. the interest of a capital of $500,000, a sum jnst about sufficient to connect Lakes St. Louis and St. Francis by a canal similar to the Lachine. But it is not fair to consider these canals as useful to the *up*-freight only, although their revenue must be almost exclusively derived from it. Hence, increasing the rates 40 per cent. above those of the Erie canal, we shall have $70,000 gross income or $40,000 nett revenue, the interest at 4 per cent. on $1,000,000 (£250,000), the greatest amount of capital which could be safely invested, as well as a sum, the writer thinks, quite snfficient to have placed the up-trade on the best possible footing. But as the almost incredible sum of $6,600,000 has been spent, or, to speak more correctly, squandered on 11 1-2 miles of the Cornwall canal, there remains only the Beauharnois and Lachine canals on which any saving can be effected by the application of common sense and a little knowledge of the western trade.

The construction of the Beauharnois canal is estimated at £255,900, the enlargement of the Lachine canal at £225,000, together, £480,900, though, judging from experience in Canada, £750,000 will be nearer the mark. Experience in the same country also shows, that £100,000 to £120,000 will unite lakes St. Louis and St. Francis by a canal similar to the Lachine and adding £30,000 for forming a proper entrance to and clearing out that canal, we have £150,000 against £480,000 by the present plan; the former sum deduced from the actual costs of the Lachine and Chambly canals, the latter directly against the actual cost of the Cornwall canal.

Not only should the least possible amount be expended on the Lachine canal, but the tolls should be immediately reduced to, at most, the rates of the Erie canal, which has no St. Lawrence to contend with. These are about one fourth the rates of the former canal, and as the Lachine is the only one which can by any possibility be extensively used for down-freight, every inducement should be offered to that part of the trade by lowering the charges.*

* The tolls on the Erie canal are 35 cents per barrel of flour carried 363 miles, equal 3.5 cents per barrel for 36 miles canal, equal $35 per 1000 barrels, to which adding charge on boat, and towing, $26, we have $61 as the total canal charges against $28 pilotage and insurance by the river. It is possible that some portion of the down trade might be drawn to the Lachine canal by adopting the rates of the Erie canal after 1st October, and about half those rates during the summer. The saving of wear in the boat and also of time—though the distance is about twice as great—are however in favor of the rapids.

It is unnecessary to more than barely allude to the present policy as leading to a very different result by enlarging the Lachine canal for a very large class of vessels, which, without any reduction of toll, are, from their *size* alone, to reduce the total cost of transportation. It may be incidentally remarked here, that there is a vast difference in the effects on this trade by increasing the capacity of vessels by improvements in the St. Lawrence, and, on the other hand, by enlarging the canals. By means of the former, an additional load is taken in the *same* vessels with a trifling additional expenditure, by the latter, a *new* and *more* costly class of barges must be built, and the tolls—the principal item of charge—are increased in the very same ratio as the load, thus in a great degree, neutralizing the anticipated advantages, besides rendering competition more difficult, on account of the greater capital required. So wretched does the writer consider the present policy, that he does not believe there is an engineer of character, even tolerably well acquainted with the trade of the lakes, who would for a moment hesitate between reducing the Cornwall to or rebuilding it on the scale of the Lachine canal, and enlarging the Lachine to very nearly the scale of the Cornwall canal:—and, so far from attracting trade to the St. Lawrence, these mammoth canals can scarcely fail to have a directly contrary effect by increasing the tolls on up-freight, and leading to odious restrictions and regulations for the purpose of forcing the boats to use the canals downwards, thus—as in New York—mistaking the means for the end.

Indeed the similarity is too striking throughout to be passed by without further notice. In both countries the great aim of government appears to be to effect a reduction of a few coppers on each barrel conveyed from the western states to the Atlantic—to accomplish this pitiful object—which they appear to regard as the great end of human existence—millions are thrown away with a prodigality contrasting strangely with the niggardly sums reluctantly yielded to establish good common roads for the farmers, the vast majority, or even to aid the great cause of education. Within a few years about 20 millions of dollars have been spent on canals in New York, from which no revenue will ever be derived—a direct tax has been lain on all the property in the state, and, for fear of diminishing the income of the Erie canal, and thus rendering further taxation necessary, the citizens of New York are prohibited from using railways for eastern freight, a restriction unknown even in the slave states. There is also another object which beautifully illustrates the results of uniting public works with politics.

If the people of New York were emancipated from their present "peculiar institution," and the trade thrown open to competition, there would be no possibility of plausibly advocating the enlargement of the Erie canal and numerous speculators and adventurers would thus lose all chance of speculation and patronage.

Canada is peculiarly an agricultural country, and nine-tenths of the population would not be in the slightest degree benefitted by any increase of western trade, though *all* must bear their share of taxation if these canals do not clear expenses. The public works required in Canada are better communications from the interior to navigable water, and, secondly, a better commmunication for travel between the eastern and western portions of the province. Without the former the settlement of the country will go on slowly—as in the counties 30 or 40 miles north and south of the Erie canal—and the latter is indispensable, if the trade by the St. Lawrence is to be anything more than a mere carrying trade *from* the western states to the Atlantic. The fare from Montreal to Kingston is (including meals) no less than $10, the time about 34 hours consuming 2 days, the distance 180 miles of which 143 are by steamboat! What would be the western trade of New York with such drawbacks? The—at least—4 millions of dollars required for the St. Lawrence canals would, as already explained, have given the greatest posible facilities to the up and down trade of the river at a cost of about one million, and the remaining three millions would have constructed railways around the rapids of the St. Lawrence, and from the western extremity of Ontario to the outlet of Lake Huron, which would bring Montreal and Sarnia almost as near, with regard to time and cost, as are now Montreal and Kingston. As these railways would undoubtedly clear expenses and interest†—there being a large business—the charge on the provincial treasury for the best desirable communications for both trade and travel would not have exceeded £8,000 per annum. The "prospects" at present are that, without either one or the other, the deficit will be from £50,000 to £70,000 per annum. The improvement of the Cedar rapids, frequently alluded to, forms no part of the policy of the Board of Works; the trifling amounts at which great benefits may often be conferred on the trade having no greater

† The advantages of the contemplated railway across the peninsula of Upper Canada are given by the writer in this Journal. The paper was written in 1837. The railway in the neighborhood of Montreal would command a large local travel, the travel by the St. Lawrence and Ottawa, the raftsmen, emigrants, etc., and is the only great public work spoken of in Lower Canada in which the writer would feel himself warranted in recommending investments.

attractions for Canadian than for New York politicians;* this plan was brought forward some time since by Mr. Henry Roebuck, and, judging from the feeling evinced in the late short session appears likely to meet with almost unusual favor in the legislature. Should this be effected during the next session, and fulfil the expectations of the projector, experience and common sense may perhaps be permitted to save something "from the fire."

If these stupendous canals prove equally stupendous failures—which to the writer appears inevitable*—their "influence on the country" may be predicted with great certainty from the results of a similar course of folly and extravagance in some of the western states. Indeed the Lower Canadians consider that the union alone saved the Upper Province from bankruptcy, and, but for the fear of disturbing their countrymen in office, would at once introduce the admirable system of finance which characterized the Lower Province before the Union. This will however soon be impracticable, and, as in New York, the people must pay by taxation the interest on the engineering capers which are cut by their rulers.

It is impossible to overrate the injury to the profession and to the cause of public works arising from these unfortunate and unprincipled extravagancies. The engineer is viewed as a man whose trade it is to aid the private or political adventurer in fleecing the public;—what individual would invest his own money in works projected by and to be executed under the direction of men who refer to the ship-canals of Canada or to the "lateral canals" of New York as evidences of their skill? to men who carefully avoid, or are incapable of applying that great principle, without which engi-

* The Chairman of the Board of Works is a Member of Parliament and of the Executive Council or Cabinet! The money is voted in the lump to be laid out pretty much as the Board pleases, and the "division of the spoils" is laughable. Of about £320,000 appropriated to common roads, £75,000 are to be expended in the Lower Province, containing two-thirds of the inhabitants; so that, according to the Board of Works, one Upper Canadian is entitled to more than eight Lower Canadians. Of the £245,000 to be laid out in Upper Canada, about £170,000 are to be laid out in the extreme western part of the province, and the rule of apportionment appears to be, that the amount expended, shall be inversely as the magnitude of the interests to be accommodated by roads as well as canals. The intelligent reader will not fail to observe that the total amount spent or to be spent on canals for forwarding is many times greater than the £320,000 to be spent on the roads to accommodate the agricultural which is twenty times greater than the forwarding interest; though it should be observed that the forwarders are not to be held responsible, as they think very little of the "ship-canals." (Memoranda, 12 Aug. 1841.)

* The great majority of persons with whom the writer conversed on this subject in Montreal and Kingston, including French and English Members of Parliament, forwarders and other competent persons entertained a similar opinion—some loud in their denunciations, others afraid to investigate the subject.

neering cannot rise to the dignity of a liberal profession—*the adaptation of expenditure to income*—of the means to the end?

The writer will conclude with remarking that no system of public works in Canada can, in his opinion, be successful, which overlooks the interests of the *Province itself* in grasping at the phantom of a western trade, of "an almost inconceivable extent," "doubling almost annually," (to use the definite language of the Chairman of the Board of Works) and that he has never been able to see the justice of that enlarged philanthropy, which, in its eagerness to add to the happiness of others, overlooks *its own*.

New York, 1843.

We cheerfully insert the communication of Mr. Trautwine's, both because we desire to do every one justice, and because it gives us an opportunity to correct a misapprehension, that may have occurred to others, as well as to that gentleman.

From the tone of Mr. Trautwine's previous communication, we thought some improper expressions in our correspondent's criticism, might have given offence, and our reperusal referred to the criticism, and not to the original article. We did not state, and did not mean to state, that we endorsed any of the views of our correspondent—a thing we seldom do—whatever may be our own opinion.

We merely intended to defend ourselves from having admitted any thing like personal reflection—and to assert in general terms, the privilege of criticising an article by means of quotations. All criticism in regular reviews, is so conducted—but of course the fairness of the quotations is a matter that may be questioned. It did not appear, to us at least, that there was any intention to misrepresent in the extracts made from the article of Mr. Trautwine, and we give place immediately to the original paper with a view as we then said, to the satisfaction of all parties and the right understanding of the matter.

Upon another examination after reading the foregoing letter we think we understand the reason of Mr. Trautwine's disapprobation of the criticism, but we presume that the very commencement of the criticism alluded to would, to most persons, explain what followed—at any rate the article itself as well as this note of Mr. T. will set all right.

We doubt not that the observation of the gentleman engaged in this controversy when turned to particular roads give more and

more clear notions upon this subject and readily explain away the apparent difference of opinion.

For the American Railroad Journal and Mechanics' Magazine.]

Mr. Schaeffer—*Dear Sir*, I was somewhat surprised in reading the number of your Journal for September 1st, to find that you endorse the criticism of your correspondent on my paper on the injudicious policy pursued on many railroads in the United States; which criticism appeared in your number for July 1st. Had I been at liberty to suppose your remarks the result of a hasty glance over my paper, I should not perhaps have been so much astonished at your mistaking the scope of my arguments; but as you aver that a reperusal of it, has only tended to confirm your previous opinion, I feel myself called upon to show that in my opinion you, as well as your correspondent, are entirely incorrect in the deductions which you have drawn from it: and must ask you to allow me the use of one or two of your pages for that purpose.

I shall not examine all the minutiae of your correspondents criticism, as my object is merely to prove that you and he have misunderstood entirely the *general principle* which it was the intention of my paper to defend. One point alone will serve for this purpose.

Your correspondent remarks that "availing himself of all the lights furnished by the trials and failures so far, Mr. Trantwine, himself, has tried to supply us with a true model and estimate of a railway. In this however he carries us back to the point at which the improvement commenced, the flimsy flat bar of 24 tons per mile, or 15 lbs. per yard." Omitting all such of my remarks as would have a tendency to prevent such a conclusion, your correspondent here leaves his readers to infer that the model and estimate alluded to, are such as I would recommend for our railroads generally: Let all my assertions, made in the most express and emphatic terms, and frequently repeated for fear of misconstruction, so to show that I conceive it to be totally unfit for roads intended for accommodation of a very heavy traffic. Thus, I say on the contrary, that "a perfect railroad would be that on which the least imaginable force would draw the greatest imaginable load," and that it "is the duty of the Engineer to approximate to it in every instance, as closely as the trade of the road, and the interest of the Company admit."

In another place I say, "the grounds of every expenditure on a railroad should be, that the annual saving thereby induced should more than counterbalance the increased cost:" and again, "I sin-

cerely trust that I shall not be accused of disaffection towards permanent railways, and heavy engines; on the contrary, I repeal emphatically, that they should be as permanent, and as heavy as the business they are to accommodate can possibly justify;" and again, "In conclusion let me earnestly request that no misconstruction be put upon the foregoing pages. There are many railroads in the United States to which my remarks are not at all applicable; but there are also many to which they are. Where there is a very heavy trade to be accommodated, I am in favor of easy grades, curves of large radii, heavy rails, and powerful engines," etc.

Now instead of giving these quotations, or any of a similar import, your correspondent has carefully refrained from even intimating the occurrence of any such in my paper. He assumes gratuitously, and unwarrantably, that I give a model, which he leaves his readers, by implication, to infer that I consider calculated for the use of all railways; and then strives to show that it is not so calculated, as if I myself had not most expressly stated that it is not.

Nothing in my paper offerded the slightest grounds for the caracature which he has drawn: and you must allow me to add that I consider you totally unjustifiable in affirming that his "quotations give a fair view of Mr. Trautwine's article." Your subsequent publication of my paper, render it unnecessary that I should reply to the remainder of your correspondent's strictures. It would be very easy to prove them all equally fallacious and distorted with the one I have selected. E uno discite omnes. Your readers have it now in their power to form their own opinions as to its merits and demerits, and I am perfectly willing to abide by their decision.

I am very respectfully
Yours, &c.,
JOHN C. TRAUTWINE.

P. S. Will you do me the favor to correct an error in my paper; viz, page 124, 16 lines from the top, between "one" and "Engine" insert *wheel of an.*

RAIL ROAD NOVELTIES.

The attention of Engineers has recently been called to two remarkable variations from the ordinary routine of invention—neither of which in fact are really new—but only novel in their application.

We refer to the Pneumatic Railway and to the employment of electro magnetic engines upon railroads.

The latter experiment recently made upon an English road, and the details of which are given in our Journal, seems to have inspired hopes of the ultimate success of this agent as a propelling power. It is true that the velocity attained was short of that which is required, but it seems that the model was a small one and susceptible of improvement. When sufficient attention shall have been paid to the laws of electricity in this form, by those who are experimenting upon this matter we may look for some still more remarkable results.

Of the other novelty as we have ventured to add it, although in a dormant condition long known—we must confer our doubts as to its success. But a new impetus has within the last year been given to it—and some confidence in its practicability has been inspired by the strenuous part taken by Mr. Vignoles in its behalf. The general reliance in this gentleman's professional knowledge and discernment has led many to believe that the invention is not chimerical as it has long been thought.

The description of the rude specimen now in operation will be found in the Report of Mr. Vignoles' lectures.

The difficulty of obtaining a sufficient vacuum has been overcome, as it has been determined that a partial exhaustion of the air is all that is necessary and at this low pressure it is evident that the danger of leakage will be much less. The means adopted for closing the valves as the train passes are explained in the notes of the lecture, but we must say that the explanation is not clear to us at least. Still the fact that an engineer of high standing has seriously taken up the matter should induce us to pay more attention to it than has hitherto been given.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING.

Lecture 15.—*Working Expenses of Railways.*—Having, in the last lecture, analysed the working expenses of railways, in reference to the train—that is, reduced to a rate per train per mile, with an average load at the usual velocity, the Professor considered it might be well to consider the same subject in another light. In the preceding mode of calculation no regard was paid to the amount of what might be called the useful weight carried. It seemed to the Professor, that the proportion between the dead weight of the engine, tender, and carriages, and the weight of the passengers and their luggage—in short, between the unprofitable and the profitable load—formed an important element for consideration, even if it did not affect the principle on which railways ought to be worked. In the common omnibus, with a full complement of

passengers, the proportion was one to one—taking the average load about five to three—or including the weight of the horses (the moving power which has also to carry itself) about three to one, or, with a full load of passengers, something less than two to one. But on the railway, owing to the far greater weight of the carriages, and general arrangement on most lines, the proportion of dead weight is much greater. In a first class carriage, as adapted for long lines, and fully loaded with passengers and their luggage, the proportion is two and a half to one, but, taking the average load, it is about four to one, and, when but little luggage is taken, four and a half and five to one. On short lines, where the trains run often, with many carriages, the proportion is sometimes as high as eight to one, or, including engine and tender as twelve to one. In an ordinary train of about seven carriages, their weight, and that of the engine and tender, may be taken at about fifty tons; the average number of passengers has, on a former occasion, been shown to be about sixty per train, or four tons without, and, perhaps, five tons with, their ordinary weight of luggage, and say one or two tons of packages and parcels paying freight, being a proportion of six or seven of unprofitable to one of profitable load; and if the carriages were all full, about four and a half or five to one, as above, and on the average, the proportion might very fairly be taken as at least five to one. It appeared to the professor that there was some radical error here, and that some arrangements were wanting to reduce this proportion, as far as the carriages were concerned, for of course, as long as the locomotive engine was used its weight would always form a large proportion of the load, particularly with light trains—though the carriages certainly required to be made strong and heavy on this system—and this seemed an inherent defect on this principle of locomotion, perhaps quite irremediable. Yet, at all events, on many lines the proportion of dead weight of carriages was much too great, and might be remedied. Of late this had been done on the Greenwich Railway, where, by combining two classes of seats in the same vehicle, much fewer carriages sufficed. There was a great contrast to this on the Blackwall Railway, where, from having a separate carriage for each station, according to the peculiar mode of working that line, the proportion of dead carriage weight was generally about three, and often four, times as much as on the Greenwich, though the carriages were of the same build. Owing to this and to other causes, extra guards, rope, etc., notwithstanding the generally admitted economy of stationary power, the expenses of working the Blackwall Railway, per train per mile, was double what the Professor found was the average for the working on several locomotive lines, and quite as high, if not higher, than the present rate of working on the Brighton Railway, which was the highest of any that had yet come under his cognisance. Although, abstractedly, this over proportion of dead weight carried was not always connected with the moving power, yet an engineer ought to point out, and, when within his control, to remedy such an evil, as the loss consequent

on carrying useless weight is equivalent to that arising from increased resistance of gravity in surmounting an unnecessary ascent —a case which every engineer is naturally anxious to avoid.

In the mode of reducing railway expenses to a mileage, adopted in the last lecture, the number of passengers, and their proportion to dead weight of carriages, had not been considered, for it was clear that the arrangement of carriages in any train being supposed to be duly proportioned to the average traffic, any addition to the average assumed load would be pure profit, and would not cause any sensible addition to the cost of the transit of the regular load, for which all the necessary arrangements of engines, tenders, carriages, guards, stations, and the whole working and carrying establishment of the railway was already provided and paid for. But, suppose another mode of considering the working expenses be adopted, viz. from the number of passengers in a train, deduced from an average of many lines for several years, or from any assumed number per train, let the cost per passenger per mile be worked out, and this will lend to the consideration of the true policy for attracting the greatest number of persons, and trying to fill the trains up, as they must go, at any rate.

The Professor then went through the various items of railway expenses stated in the former lecture, and brought them out in decimals of a penny per passenger per mile—the result being, that, taking account of experience gained and applied, and economical arrangements duly introduced, the expense of locomotive power might be taken at $\frac{1}{4}d.$ per passenger per mile, which was coming back to the original estimate made for the working of the London and Birmingham Railway. Other expenses, including Government duty, would bring the total up to two-thirds of a penny, and, under favorable circumstances, of well filled carriages, this might sometimes be brought down to $\frac{1}{2}d.$, but taking the average of lines as now worked, the cost was about $1d.$ per passenger per mile. On many of the American railways the cost was as low as $\frac{1}{4}d.$, and for long lines on the continent, in India, etc., where wages were low, and coal or wood might be got very cheap for locomotive fuel, and no rates or taxes on profits and passengers were laid, the charge of carrying passengers per mile might be fairly taken at $\frac{1}{2}d.$ only. Now, if the proportion between the unprofitable and the profitable parts of the load were reduced to three to one, as regarded carriages only, and six to one as regards the whole weight of the train the expense of carrying passengers, taken by weight, will be still at least three times as expensive as carrying goods only at the same velocity, the proportion being of wagons to goods as two to three, and of the whole train, including engine and tender, at less than two to one, and with heavy trains, of goods only, about one to one, and for coal and mineral traffic, at diminished rates of travelling, still less. The Professor observed, that the cost of conveying merchandise might be taken at about $1d.$ per ton per mile for railway expenses only, exclusive of collection and distribution at the termini of lines, and that of coal and minerals at about $\frac{1}{2}d.$ per ton per mile.

With these elements, therefore, of the expense of working railways either per train, or per passenger, or per ton, it is for the politic manager of a public concern to consider what should be the rate of charges above these cost prices to make to the public, so as to induce the greatest amount of traffic. Mr. Vignoles then observed, that there was a third way of considering the subject of the working expenses of railways, in reference to the number of engines employed, which was the mode adopted by the Irish Railway Commissioners, and which was, perhaps, the proper way of calculating the annual cost on lines of little intercourse, on which, however small the traffic might turn out to be, yet a certain number of engines must be kept to do any work at all. The commissioners, in following out this inquiry, endeavored to determine the proportion the cost of locomotive power bore to the total working cost of a railway. For the Liverpool and Manchester line it was found that this proportion was only one-fourth the gross annual charges on that line, including much town carriage of goods collected and delivered; but on the Dublin and Kingstown Railway the proportion was, at that time, nearly one-half. It was observed by the Professor, in a digression, that for the average of railways it was now determined to be about one-third. The commissioners finally assumed the cost of locomotive power to be one-third of the total expense of working a line of mixed traffic, and that to run a given number of trains per day, a certain number of engines must be provided; it was then calculated that £1750 a year would be the cost of each engine to work about from 25,000 to 30,000 miles annually, and then they computed the amount of gross receipts necessary to cover those expenses and interest of capital. This was working backwards, to ascertain whether it is justifiable to make a railway at all in certain districts. The result of the commissioners' calculations were, that, supposing there went only two trains daily throughout a given line, the average load of each train ought to consist of either fifty tons of goods or eighty passengers, or a mixed load of twenty-five tons of goods and forty passengers, or in that proportion, in order to justify a line being made—the average charge for passengers being assumed each 1½*d.* or for goods 2*d.* per ton per mile, which, it may be obsered, is scarcely the half of the average rates of charge on the principal English railways. Mr. Vignoles observed, in conclusion, that having shown that the cost of conveyance of passengers, merchandise, minerals, etc. could be nicely calculated from the experience gained, and could be brought to the definite mileage rates before mentioned, *he thought the proper railroad charge should be, double the cost for working;* which when the railways had been judiciously constructed, and without extravagance, would sufficiently remunerate the undertakers, as such moderate principle of charging would bring the most traffic.

[From the Journal of the Franklin Institute.]

REMARKS ON THE INJUDICIOUS POLICY PURSUED IN THE CONSTRUCTION AND MACHINERY OF MANY RAILROADS IN THE UNITED STATES. By *John C. Trautwine*, Civil Engineer.

[CONTINUED FROM PAGE 125.]

The argument is not admissible, that perhaps in ten or fifteen years, the business of the road may increase to such an extent as to pay a profit on its cost. If the engineer wishes to ascertain if this be acceptable reasoning; let him suggest it to the stockholders before the road is commenced, and I suspect he will find but few to acquiesce with him.

But I see the sceptical reader elevate his eyes in astonishment. "What," says he, "the old flat bar! light engines! heavy grades! Is it possible the writer expects his readers to subscribe to so antiquated and exploded a creed as this? Even supposing his road to answer very well at first, with the limited business assigned to it, what will be done with it when the trade increases? *Ours* is a growing country, and the present business is no criterion to act on: in a few years it will have increased fifty, nay, a hundred per cent.; what is to be done then?"

The answer readily suggests itself: if the business increases 100 per cent., put on four engines instead of two. "But, ah!" says the objector, "there I have you. Don't you know that one heavy engine will draw a given amount of freight at less expense than a greater number of light ones can?" I most assuredly do know this to be true in the abstract; and I know, moreover, that a blind adherence to this "abstraction," has nearly ruined more railroad companies than one, in the United States. Let us illustrate this, also, by an example. Suppose our $10,000 a mile road to be finished, and in operation; its little models daily steaming it modestly over the line, with their thirty tons gross; and the stockholders annually pocketing their eight per cents. "nett." This all does very well for a time; but "ours is a growing country," and soon the business on our road increases one hundred per cent. What is now to be done, is the question. One heavy engine can take all our increased freight at one load, at an annual expense for the maintenance, of but $5000; while on the other hand, if we employ two small engines to carry it, we incur an expense for maintenance of motive power, of some $9000 per annum. "Here is a pretty piece of business," say the Directors; "why did not our engineer foresee all this: here he has entailed on us an annual loss of $4000, at the very least. Did not experience, all the world over, show that railroads attracted new business to themselves? Did he not know that heavy engines were more economical than light ones? Did he not see that they were introducing them on all the English railroads? However, what is done cannot be helped; we have been behind the age long enough: let us try to catch up with it at last; let us order a thirteen ton engine, or rather, as the business will certainly continue to in-

crease, let us get a twenty ton one, at once." This is accordingly done; and the "fell destroyer," this "monstrum horrendum *ingens*," is trotted out. They build a fire in him;—he snorts;—he starts;—he is off. "Ah! this is something like; now we are up with the age." But, alas! in a few months things undergo a change. Rumors, faint at first, but gradually gaining strength, reach the Directors' ears, that something is going wrong on the road. An investigating committee is appointed; they visit the road, or rather the spot where once it stood; for the road itself has vanished: it is "*non est.*" After a long and laborious investigation, assisted by several scientific and practical gentlemen, the committee report that, first of all,—the bar was mashed into the timber;—and then—the timber was mashed into the ground. They moreover state their conviction that the flat bar has proved itself utterly unfit for railroad purposes; and suggest that as the Directors of the Liverpool and Manchester railroad have recently found it expedient to adopt an edge rail, weighing seventy-five pounds to the yard, *therefore* a similar rail should be substituted for the miserable flat bar on their road. The heavy rail is accordingly ordered, and laid down. "Now we are certainly up with the English; we have as heavy engines as they have, and as heavy rails; therefore, the road *must* pay well. We can carry sixty tons with our new engines, as easily as we could carry thirty with our old ones, and at very little more expense; that settles the matter. If the road yielded eight per cent. before, it must unquestionably yield sixteen per cent. now, with double the business; and the expenses of transportation only the same as originally."

This certainly looks somewhat plausible; but it is found, notwithstanding, that somehow or other the road now don't pay at all. "What! our miserable flat bar road, and tea-kettle engine, pay eight per cent., and our edge rail, and twenty ton engines, a losing concern? How does this happen?" It happens thus: *the road has now cost too much;* eight per cent., on a road costing $10,000 per mile, is but four per cent., on one costing $20,000 per mile; and in our order to England, we omitted one very essential item to the success of heavy rails and powerful engines, and that is, a heavy trade. Now, had we, when our business increased 100 per cent., merely put on two more small engines, every thing would have worked very well; and the road would in this case have yielded sixteen per cent., instead of eight. It is true, that two heavy engines could, at an expense of maintenance of but $10,000 annually, have done the work of the four light ones, which cost annually, perhaps, $18,000; but in order to save this difference of $8,000, we must have had a road proportioned to the heavy engines; and to secure this would probably require an expenditure, the interest on which would be many times greater than the $8,000 saved on the engines.

The foregoing is, of course, but an imaginary case. Still it serves to illustrate the principle, or rather, *want of principle*, on which far too many of our railroads are now being constructed,

all over the Union. We see whole states falling into the error; indeed, we are falling into it, nationally.

I conceive that this mania for the *indiscriminate* use of heavy engines and rails, has done more injury to the railroad cause, than perhaps any other single consideration that has been brought to bear upon it; but "Dulce est desipere in *Loco*," appears to be the general motto, and it is probably useless to cry out against it. No position can be more tenable, more absolutely palpable, than that it is true economy to use the very heaviest engines, and best constructed road, *that the business requires*. But what constitutes a heavy business in one case, may be a very light one in another, and vice versa. The matter admits, in almost every instance, of calculations sufficiently approximate to determine the class of road, and machinery, that should be adopted; and had this expedient been resorted to on all our railroads, we should probably not have had a single one in the United States, yielding less than ten per cent. on its cost.

I sincerely trust that I shall not be accused of disaffection towards permanent railways, and heavy engines; on the contrary, I repeat emphatically, that they should be as permanent, and as heavy, as the business they are to accommodate can possible justify. What would we think of a company who should purchase the Great Western steam packet, to ply hourly across the river at Philadelphia, with some five or ten passengers at a trip? Would we not pronounce them demented? And should they tell us that Philadelphia had gone on increasing so rapidly, and so regularly, for many years past, that they felt confident their number of passengers would increase 100 per cent. in ten or fifteen years more, would that diminish our suspicions of their insanity? But yet does it follow, because the Great Western would not be a profitable investment in this case, that therefore she is not a fine sea vessel, and admirably adapted to carry on a lucrative business between England and America? Or does it follow, that because *she* was a losing concern when running between Philadelphia and the opposite shore of the river, that therefore a first rate, substantial little steam ferry *boat* should not do an excellent business on the same route? Or, lastly, suppose that the engines of the two boats, should be respectively converted into locomotives, for accommodating precisely the same limited amount of business *on land*, does that in any degree alter the case? Is it not equally apparent in either instance, that the magnitude of the *trade*, and not of the *boiler*, must be depended on as the great prime mover of the enterprise? I certainly should consider the engineer who would advise the same character of road, and machinery, in every case, fully as deficient in judgment as the company who should convert the Great Western into a ferry boat.

The remarks applicable to heavy engines, apply also to heavy cars. To diminish the weight of the engines, and still allow that weight to be exceeded by the cars, were evident impolicy. As before remarked, I should on our road, limit the weight on any one

wheel, to one ton; and should, consequently, so proportion the cars, as that when loaded they should not exceed that limit.

We often hear the remark, nay, I presume that nine engineers in ten, throughout the profession, will yield it their unqualified assent, that the power of an engine is less on the flat bar, than on the edge rail, by some twenty or twenty-five per cent. In *strict justice*, I suspect there is no foundation for this assertion. I doubt not that an engine *adapted to the flat bar road*, will be found to exert quite as much power on it, as on the edge rail; but, unquestionably, if we place on it engines, so heavy as to crush it, and deflect the timbers, a different result must follow. Indeed, it would not be difficult to conceive of an engine so heavy as to deflect the road to such an extent, as almost to deprive her of all locomotive power.

The examples assumed in the foregoing pages, have been taken at hazard, merely for the purpose of illustration; but so far as the character of road, and engines, which I have suggested, are concerned, I am of opinion that they will be found in very numerous instances, preferable to light grades, heavy edge rails, and powerful engines; particularly on the score of original expense. Roads built after this plan, will not partake so much of an experimental character, as those involving greater outlays; and, moreover, they would be adequate, under proper management, to accomodate, with perfect ease, far more trade than passes over half the roads in the Union. For example, there are few of our roads doing a business as great as could be taken at two trips daily, in each direction, by eight ton engines, over sixty feet grades. What folly is it then in such cases, to double the cost of the road for easy grades, heavy rails, and powerful engines? The arguments usually brought to bear against advocates for cheap roads is, that the business will soon increase to such an extent as to pay well on the cost of a first-rate road. This may be true in many iastances, but there are more cases to which it is not applicable; for even admitting that the business did, in ten or twenty years, increase 200 or 300 per cent., it by no means follows, that even *that* amount would justify a first class road.

The engineer is not left altogether to the exercise of his discretion, or judgment, in the matter, It admits, as before stated, of an arithmetical determination, having the data of the probable amount of trade that will be accommodated by the road. In collecting this data, he should shun alike, assumptions based upon the probable business of the road for the first day, or even week, or month, or year, of its going into operation; and thus having in view the prospective resources at the termination of the coming half century.

I will here take occasion to remark, that more, both of time and skill, will be required, to locate a railroad on the principles I have advocated, than on the ordinary plan. When, as is usually the case the route is located, in a great measure, with a view to long stretches of straight lines, easy curves, and light grades, the "modus operandi" is much less complicated, than when the engineer shall be obliged, at almost every step of his progress, to test his cuts, curves, etc.,

by the standard of justifiable expenditure. It is a very easy matter for the engineer to draw a long straight line on his map, and then tell his assistants to run it out; but it will be somewhat more difficult to decide on that line, between the same points, that shall best subserve the pecuniary interests of the company. In the one case, the route may be located *by miles;* in the other, it must be done *almost by inches.* Perhaps every engineer will bear me out in the assertion, that the difficulties of a proper location must be inversely as the finances of the company, should this system be adopted. As before remarked, the present plan has but little, if any, reference to that point.

I shall not attempt to follow Mr. Ellet into those cases which he supposes, in which it may become advisable to assume grades, more nearly coincident with the natural surface of the ground, and to dispense with the use of iron rails altogether; using cars no heavier than a light barouche. I may, however, be permitted, en passant, to express my entire assent to his views in that particular. Many short branches, from great thoroughfares to watering-places, or to small towns, might be constructed, and made to pay well, could we but divest ourselves of our "stereotyped" notions of what constitutes a good railroad. Witness the railways laid in coal mines: there are none more serviceable;—there are none that pay better; yet they do not cost $20,000, or $30,000, a mile; nor do they ever feel the weight of even a *model* locomotive. How powerful an appeal do they make to us, *to proportion the means to the end.*

I will now add some further remarks in support of my views respecting the location of a line of railroad; and again let me express the hope that I shall not be misunderstood as expressing my ideas of the best *abstract* line, but of the best *paying* line;—not that on which a load can be propelled by the least expenditure of *power*, but by the least expenditure of *money;*—not that whose merits are apparent on the ground itself, but which are evidenced forth resplendently, in the countenances of the stockholders, as they button up their pockets, on dividend day. I am fully aware of the obloquy to which an engineer exposes himself, in lifting up his feeble, and almost solitary voice, against any of the prominent evils of the day; and I am therefore the more desirous to be distinctly understood.

On nearly all our railroads, of any length, there occur at various points, maximum grades, of from thirty to fifty feet to a mile. These grades limit the capacity of the engines; and one such occurring on a road, (unless additional power be employed at that point,) does this quite as effectually as fifty would. Yet on the same road, we almost universally (perhaps *universally,*) see very great expense incurred all along the line, to secure much lighter grades, even where somewhat heavier ones would have coincided with the natural surface, and have involved little or no expense. This practice, *at least to the extent to which it is generally carried,* (for there are many exceptions,) I look upon as radically wrong.

Undulations in the acclivities of a railroad, it is admitted, must be allowed to a certain extent; but the precise limits of the ex-

pression, "certain extent," it is needless to say, have not been as yet defined. The application of the term must, of course vary in each separate road; and perhaps its most literal interpretation, as sanctioned by practice, would be, "Such as the engineer considers the nature of the ground to require." This construction I should be willing to modify, by adding, "and the best interests of the company demand."

Admitting then, *that acclivities must occur* on the line, affecting the load of the engine, I am under the impression that the *number* of them may be increased greatly over what is customary; or, in other words, that the graded surface may be made to conform much more closely to the natural one, than is generally done; and that it would be to the interest of companies, were that system adopted. Under such circumstances, a succession of undulations, within limits not too restrictive of the speed of the engine, it is well known would involve no loss of either time, or power, injurious in practice.

It is true, that Robert Stephenson, Esq., Civil Engineer, in his report to the directors of the London and Birmingham railroad company, on the subject of undulatory railroads, objects that the variations in speed attendant on alternate ascents and descents, would create an irregularity in the intensity of fire in the engine, which is calculated to injure their boilers by frequent expansion and contraction;—and he states, moreover, that the parts of an engine should be calculated for a certain degree of speed; and that rate maintained as regularly as practicable while on duty, in order to secure the attainment of the most effective performance. He speaks, however, with regard to the "*undulatory system*," so called, of Mr. Badnall; and from one of his observations, I suspect that his remarks are not intended to apply to such rates of acclivity as those I refer to; or to such as would permit the engine to start up them, with her load, from a state of rest. For he says, "*Inconvenience would, in my opinion, result from not having the power to halt at any given point on the line of railway. This may be done, without inconvenience, on a line of road not possessing inclinations beyond the power of the engine.*" Such inclinations, my suggestions, of course do not embrace.

This is, then, the only objection (if indeed it be one) that I have ever seen, that appears to militate against the adoption of a constant succession of short undulations. Should there be others, that have escaped my notice, I have little doubt but that they would be countervailed many fold, by the saving of expense accruing from their adoption, on almost every road in the Union. Indeed, many of our roads might, in my opinion, have been materially improved, by applying the saving that would have been thus effected, to the reduction of their maximum grades. The profile of the road would, it is true, in this last case, present a greater number of undulations; but both the time, and expense, of overcoming them, would be less than in their present condition. The increased facility of drainage, in a railroad of this undulating character, should be taken into

consideration, in deciding on its adoption or rejection. The draining of long level reaches, is, in some cases, a matter of considerable difficulty. I doubt not, most of my professional readers can recal instances in which this inconvenience could have been obviated, and a far better road-bed made at much less expense, by the use of moderate undulations, in which the acclivities need not have been one quarter so steep as the maximum grade. None but a very inexperienced engineer would abuse this system, by so arranging his undulations as to create a continual variation in the speed of the engines, so considerable as to become a source of annoyance to either the passengers, or the engine-man.

But there is, unfortunately, a very powerful antagonistic principle, subject to no laws of either science, common sense, or economy, that is too frequently brought to bear upon the grades, curves, etc., of our railroads; and that is, a puerile pride: a determination to have a *handsome* road, at all events. We know that a succession of ascents and descents, mars the beauty of a straight line most deplorably; and as the expense of the cosmetic is paid by the stockholders, and they are not aware of its precise amount, it does not matter so much to the engineer, if the road, in consequence of these superfluous embellishments, should happen never to realize any dividend. In this case, nobody ever thinks of attaching censure to him: the road is very straight, and very level; and, in their opinion it follows that the engineer has done all that was in his power to make the project succeed. The amount of trade he, of course, cannot control; and the very fact of his having ruined one road, thus becomes his strongest plea for procuring the management of another. Had he made a road that would pay well, his professional character would probably have suffered an injury, from which it never would have recovered. Until the *public*, therefore, as well as engineers, begin to view this matter in its proper light, we cannot reasonably hope to see the proper remedy applied. A long straight line is considered quite a stepping stone, by our aspirants after professional fame. It shows for itself; and speaks for itself; silently, but convincingly. A straight line, five or ten miles in length, creates more *talk*, and begets more *honor*, than a judiciously curved route could possibly do; although the latter would have answered just as well, and have cost many thousands less. The public must learn, that in a railroad, as in women, beauty is not a safe criterion of merit.

Another frequent source of unnecessary expense in the location of railroads, is the attendance of a "Committee of Survey," appointed from among the Directors, *to assist the engineer in making his location!* The primary object of this committee, we are in charity bound to suppose, is to prevent, by their intuitive skill, too much use of the level and compass; at least, this is certainly all they ever *do* effect. These gentlemen are generally as innocent of all knowledge of the principles of a location, as "the child unborn;" and, by their twaddle, they soon torment the very life out of the engineer. Their questions, and remarks, must be listened

to; and to do this is utterly incompatible with any attention to the location. This demands, at every step, the undivided observations of even the most skilful engineer; and admits of no diversion from the main object. Therefore, after a few miles are located, the engineer, completely exhausted by his double duty, invokes all sorts of maledictions upon the committee, and determines upon the long-straight-line system, as the only relief from his misery. He starts his corps off at a tangent, through thick and thin, for some object several miles distant; and *then he is at leisure to talk.* He is commended for his long straight lines; the committee for their vigilance; and the stockholders pay the costs.

Let Directors, if they *must* appoint "Committees of Survey," give them instructions to *remain at home, and let the engineer alone;* and further, if he reports that he has finished his examinations, and surveys, in an unprecedently short time, discharge him, and procure another to make a thorough and correct survey. They will generally save at least one-third of the costs of their grading by this process. *It must be a long purse that pays for a short survey.* Although I have treated this subject in a somewhat sportive manner, it is nevertheless one worthy of the most serious consideration. Let Directors employ an engineer, in whom they can place *unlimited* confidence for professional skill and integrity; then give him his general instructions, if they have any to give; and afterwards leave him entirely to himself in his operations. And especially let them in their mercy, refrain from urging upon him their sons, nephews, and other "very talented young gentlemen," as assistants. Let him choose his own assistants; and let the Board abstain, most religiously, from any interference with them. They are the engineer's tools, by which he carries his plans into execution. No one else should meddle with them; to do so, will inevitably blunt their edge, and give to both the workman, and his employers, trouble and expense. Harmony among the officers is all essential to the proper prosecution of any project; and the remark applies with peculiar force to works of internal improvement. The engineer, if he be the kind of man above supposed, will feel himself identified with the work under his charge. His interest, his pride, his professional character, are all concerned in its success. No stockholder, no director, can possibly feel that intensity of interest in it, that he does. Every effort he can make, will be brought to bear upon its successful accomplishment: but let once the Directors begin to meddle with his operations; let them pass along the line, and give directions to his assistants, or contractors; let them evince any want of confidence in his integrity, and the charm is dissolved. His interest is changed to disgust. His profesional pride no longer sustains him, and inattention must inevitably follow; and just so certainly as that happens, the work must suffer.

If Directors could consent to leave the principal management of the matter to the engineer, there can be no doubt, that in almost every instance, he could either prevent claims for land damages entirely, or else reduce them to a very unimportant item. But to ef-

fect this, it is essential that he should act either alone, or through a discreet agent, who must be entirely in his confidence, and *under his control.* A sum sufficient to defray the engineering expenses of the entire work, could thus be saved, in nearly every case; but it can be done only through the engineer; and not even through him, unless he be permitted to keep his own secrets, until the whole matter is arranged. It is not my intention to treat on the management or conducting of a railroad, after its completion. I will merely observe, that it is a great error to entrust it, as is almost universally done, to men of very limited information. The general agent of transportation, under whose direction the operations of the road are conducted, should be an engineer, of considerable attainments; although it is not necessary that he should be one of the first grade. The professional ignorance of most of the conducting agents of our roads, is a lamentable source of waste. Many of our unproductive works could be made profitable, by a change in that department alone.

In conclusion, let me again earnestly request that no mis-construction be put upon the foregoing pages. There are many railroads in the United States, to which my remarks are not at all applicable; but there are also many to which they are. Where there is a very heavy trade to be accommodated, I am in favor of easy grades, curves of large radii, heavy rails, and powerful engines. But in all cases, these traits should be combined only so far as *the interests of the companies will justify.* I maintain that our engineers should construct their roads, with a view to *paying* well, instead of *looking* well; and that in looking to England for precedents, they should rather apply the *principles* there developed, to our own case, than attempt to indulge in an imitation of their splendid *practice,* when so doing must necessarily bring ruin upon those who embark their all in the enterprise. Nothing can be more evident, than that we have, in numerous instances, transcended the limits between *abstract* and *practical* perfection in our railroads. The former, as before remarked, is that in which the greatest load can be propelled by the least *power;* the latter, in which it can be done at the least *expense.* The expression, "a good railroad," is a *comparative* one; we have erred all along, in supposing it to be *positive.* It is to correct this evil, at least partially, that I have been induced, on the perusal of Mr. Ellet's pamphlet, to add my exertions to his, by the publication of these pages. Being written on the spur of the moment, and in the order they presented themselves, on reading his pamphlet, my remarks are, of course, crude and incomplete. The subject admits of much enlargement, and I hope to see it followed up in future numbers of the Journal, by more vigorous pens than mine. In the meantime, I cannot do better than to recommend to those who wish to see it more ably handled than they have found it in this paper, to study carefully Mr. Ellet's judicious remarks, in the pamphlet alluded to.

Tennessee, February, 1842.

"*The History of the Canal of Katwyk, (Holland) with a Description of the principal Works.* By the Chevalier F. W. Conrad, translated by Charles Manby, Secretary, Inst. C. E.

This communication is divided into three parts:—1. The introduction; 2. The history of the Canal of Katwyk; and 3. A description of the principal works.

1. The introduction gives the general outline of the locality of this canal, which is probably one of the most useful and extensive works undertaken in Holland, for the purpose of draining the low lands and rendering them capable of cultivation; it is carried in a north-east direction from the village of Katwyk-binnen through the sand-banks to the North Sea, where it is terminated by five sea locks: it was undertaken for the purpose of draining the district called "Rhynland," a succinct account of which is given, with details of the early attempts at draining, such as the embankments of Marendyk, those of Spaarndam, etc., tracing them up to the time of Count William the Second, king of the Romans, in the year 1253; at which period the level of the district was identical with that of medium tide, and each "Polder" (or spot of cultivated land) was separately protected from the spring tides by an embankment; a change has occurred in the relative levels, whether by the sinking of the land or the elevation of the sea is, it appears, a subject of dispute, but it is certain that the level of the river Y and of the Zuyder Zee is now much above that of the Rhynland district. The natural consequence of this change, has been to increase the demand for artificial drainage by canals, and of windmills for pumping, and also the establishment of local boards of direction, whose duty is the superintendence of the works for the protection of the lowlands.

The district of Rhynland contains 127,000 bonniers or 317,500 English acres, which is thus divided:—

	Bonniers.		English Acres.
1. Polders, or Districts embanked and drained by windmills.	54,831	=	137,077·5
2. Lakes and Peat-bog already laid dry.	15,262	=	38,155·0
3. Land without mills and sandbanks on the borders of the North Sea.	32,630	=	81,575·0
4. Lakes, Canals, Ditches, Peat-bogs abandoned, etc.	24,277	=	60,692·5
	127,000	=	317,500·0

The drainage is effected by 268 windmills, working scope wheels or Archimedean screws.

Within this district, is included the Lake of Haarlem, which alone extends over 18,000 bonniers or 45,000 English acres; the drainage of it is now commenced and will restore a tract of very valuable land.

The enumeration of the original locks at Spaarndam and other places, is given, showing their incapacity for carrying off the waters, particularly when unfavorable winds prevented their free current into the Y, and hence the necessity for the canal of Katwyk and the choice of that particular spot, which is not affected by the prevailing winds.

2. The historical portion of the memoir, treats of the naturally unfavorable position of the district for drainage; it mentions a project for a canal at Katwyk in the year 1404, as related by Professor Lulofs,* on the authority of the historian Van Mieris; and enumerates all the various examinations of the levels, the projects of tunnels, canals, etc., the appointment of numerous committees, the local opposition to the several plans, the repairs of the embankments, which had become so expensive that the landholders abandoned their estates, rather than pay the cost of preserving them; the attempt to form a small canal through the sandbanks, which was either closed by a heavy storm or was suffered to fall to decay; the effect of the siege of Leyden by the Spaniards in 1573–4, when instead of draining the country, every attempt was made to cause an influx of the waters to annoy the invading army. It appears that subsequently the expense of renewing the hydraulic works would have been so considerable, that they were in a great measure abandoned for a time. In 1627, attention was again given to the subject, and Katwyk was pointed out as the only spot for an effectual system of drainage. The map by Bolstra, which the author promises to send, shows all the plans with great precision.

The reports are then given of all the various engineers and scientific men on the drainage of the Lake of Haarlem, in all of which the Canal of Katwyk is a principal feature. The very able tract by Mr. Twent on the state of the drainage of Rhynland, and the necessity for a canal at Katwyk, is mentioned as one of the principal causes for its final construction. After the publication of this tract, Mr. Brunings, in the year 1802, caused the nomination of Mr. Conrad (the father of the author) and Messrs. Blanken, jun. and Kros, to report upon the project; which they did with such effect, that in May 1804, it was ordered to be executed by the reporters, under the superintendence of Mr. Brunings, the director-general of the "Waterstaat;" the plan selected being that which was laid down by Mr. Conrad. In August of the same year, the works were commenced, and in 1805 were so far advanced, that in June the first stone of the inner lock was laid; Mr, Conrad, who in consequence of the decease of Mr. Brunings had assumed the chief direction, carried on the works with such activity, that they were entirely finished by the month of October 1807, without the occurrence of any accident, although they had to support several very severe storms during their progress. On one occasion just as

* Lulofs' Treatise on the Elevation of the Sea and the Depression of the Land on the coasts of Holland. Transactions of the Society of Haarlem p. 1, f. 88.

the masonry of the locks was finished the level of the tide was raised by a storm 2·36 metres (2·54 yards) higher than usual, carrying away the external cofferdam, but such was the solidity of the masonry that it resisted perfectly.

A steam-engine was fixed for pumping up a head of water for scouring the sand from the exterior canal; and the final opening of the canal took place with great ceremony on the 21st October, 1807, when a medal was struck to commemorate the event, a copy of which is given by the author to the Institution.

Mr. Conrad made a series of experiments which completely proved the efficacy of the works, and then was carried off within the short space of three months from the termination of his successful labors, which will hand down his name to posterity, as the projector and executor of one of the most useful engineering works on record.

A slight sketch is then given of the origin of the Lake of Haarlem, the cause of its extension, and the works already executed in anticipation of its eventual drainage.

The third part consists of a detailed description of the principal works at Katwyk, with their dimensions, and the necessary references to the drawings which accompany the paper.

The length of the canal from the Rhine to the sand-banks near the lock, is 2260 metres (2471·53 yards) of an average depth of 2·20 metres (2·40 yards) beneath the conventional height of tide for the kingdom of Holland, from which all tidal measures are taken; it corresponds with the average tides of the river Y; the common tide at Katwyk falls 0·60 metres (0·65 yards) below and rises 1·02 metres (1·115 yards) above that standard.

From that lock to the next is 490 metres (535·86 yards) of the same depth; the additional canal is 1108 metres (1211·70 yards) long, the widths at the standard level vary between 12 and 40 metres, (14·21 and 43·74 yards) and the side slopes, which are all puddled and covered with turf, vary between 1 to 1 and 3 to 1.

The outer canal which has been made chiefly by scouring, is 151 metres (165·13 yards) long, to low-water mark, at a depth of 0·47 metres (0·5139 yards;) below that point, it is 37.67 metres (41.19 yards) wide and the sides are constructed of fascines covered with stone.

The principal works enumerated are—

1st. The sea locks (buiten sluis.)

2nd. The interior lock (binnen sluis.)

3rd. A bridge of three arches at the sea locks, with balance gates and rising sluices.

4th. A bridge of two arches over the canal in the Noordwykerweg.

The five sea locks are each 19.78 metres (21·63 yards) long and 3·77 metres (4·12 yards) wide; with the mouths of the out-fall culverts 1·88 metres (2·05 yards) below the standard tide level. They are founded upon piles of red and white deal, with sleepers, and the whole faced and covered with deal plank sheathing.

The masonry of the foundations and of the principal part of the construction, is of blue limestone from Escosine, squared and well bedded. A hard stone called "klinkers" is also much used for ashlar work, and an inferior quality of stone for rubble-work, with bricks.

The mortar used up to a short distance above the standard tide level, was made from stone lime, and above that, of lime made from sea-shells; cement was also used in several parts.

The modes of constructing these various works are given in minute detail; many of them, differing materially from the English method of construction, possess great interest; particularly those which relate to the embankments and the fascine work.

A description is then given of the Canal of Oegstgeest, which is a prolongation of the Canal of Katwyk for the purpose of bringing into the latter, the waters from the Lake of Haarlem; as well as a means of carrying off the waters of a portion of Rhynland, during and after the drainage of the Lake.

In consequence of the establishment of this canal, the Canal of Katwyk required to be enlarged, which was done to the extent of rendering it 52 metres (56·86 yards) wide, with an average depth of 2·20 metres (2·40 yards) below the standard level. The bridges were also enlarged, and it is now contemplated to add two openings to the inner lock, those of the sea locks being already of sufficient capacity.

Having described the works in detail, the author enters into some general remarks upon the effect produced by the canal, one of the principal being its beneficial use in determining the possibility of draining the Lake of Haarlem. Thirty-five years of experience, have demonstrated that this canal is the surest remedy for the peculiar position of the district of Rhynland with regard to drainage; the constant action of the North Sea has made no impression upon the simple but solid masonry of the sea locks, in fact, the Canal of Katwyk appears to be one of the most remarkable hydraulic works ever constructed for the protection of Holland.

The author concludes the paper by stating, that although he could with difficulty spare the time from his professional labors on the Amsterdam railway, of which he is the engineer, he was induced to undertake the labors of drawing up this memoir, by the subject being one of those proposed by the Institution of Civil Engineers, in the list for Telford and Walker Premiums for 1842, and by the desire of doing justice to the memory of his father, whose early decease alone prevented his name from becoming as extensively known as his talents deserved.

The paper is illustrated by nine comprehensive drawings and charts, with some lithographic views, a portrait of Mr. Conrad, sen., and the medal which was struck on the occasion of the first opening of the sluices.

Iron as a Material for Ship-building. By John Grantham.

"The first iron steam-vessel, and the first that ever put to sea, was built at the Horseley iron works, for the river Seine, and called

the 'Aaron Manby,' after the name of the projector and builder. I have lately been favored by Mr. Manby with the particulars relating to this vessel, which are very interesting as recording the origin of iron steam-vessels. He states in his communication, dated 19th February, 1842, that under a patent which he took out in France for iron steam-boats, in 1820, he, with his friend Captain (now Admiral Sir Charles) Napier, formed a society, and immediately began to construct the first boat at Horseley, but owing to some circumstances connected with the parties at Paris, she was not completed till the end of 1821. She was then sent to London in parts, and put together in the Surrey Canal Dock. She took in a cargo of linseed and iron castings and Captain Napier took charge of her, and navigated her from London direct to Havre, and thence to Paris, without unloading any part of the cargo, she being the first and only vessel of any description that ever went direct from London to Paris. Mr. Manby continues, 'Some time after, I built another iron steam-vessel of the same description, with a few alterations, at Horseley: but, owing to the navigation laws in France, she could not be admitted, and was obliged to be shipped in parts, and I put her together at Charenton, near Paris, where I had then established iron-works, and where I subsequently constructed two other iron steamboats, the whole for the navigation of the Seine. They continued prosperously at work till 1830, when, owing to the Revolution, and some disputes among the shareholders, they were sold to a new society. In this new society I had no further interest, but they continued navigating up to the period of my quitting France, and I believe are all at work at the present time. From 1822 to 1830 the hull of the 'Aaron Manby' never required any repairs although she had been repeatedly aground, with her cargo on board.'

"The next iron steam-vessel with which I am acquainted was one built by the Horseley Company, under my father's (Mr. Grantham, sen.) superintendence. This vessel was commenced about the year 1824; was put together in this port (Liverpool,) and after a series of delays, crossed the Channel in 1825, and proceeded to her destination, Lough Derg, on the river Shannon. Since then she has been constantly at work, and is now in good condition.

"Shortly after this time, Mr. John Laird of North Birkenhead, commenced building them on a large scale, and has since been extensively and successively engaged in this pursuit. Mr. Fairbairn, of Manchester, also very early took an interest in iron-vessels, and was a party to a series of experiments made at Glasgow, in which iron vessels were employed.

"The 'Ironsides' was the first iron sailing vessel of any magnitude that was employed for sea voyages, and she has been highly successful. She has made three trips to and from South America, and fully realizes all the advantages proposed in her construction."

In a letter from Charles Wye Williams, Esq., dated Dublin, Aug. 21, 1842, he says, "The old iron steamer called the 'Marquess Wellesley,' built for Mr. Grantham at the Horseley Works, is still

working and in good order. I went in her recently through Lough Ree and some of the tributary streams that run into the Shannon." —Sec. Inst. C. E.

"*On the construction of Model Maps, as a better mode than Sectioplanography for delineating the Drainage and Agricultural Improvements of a Country, or projected lines of Railways, Canals, etc.*" By John Bailey Denton, Assoc. Inst. C. E.

This communication was accompanied by a map in relief of an estate, as a specimen of the method which the author recommends. The subject of mapping in relief is not new, and the author had previously published a treatise on the subject, but having made extensive experiments, he was enabled to bring the subject before the Institution in a more defined form, showing that the construction of the models had been reduced to a simple and cheap method. These models are peculiarly recommended for pointing out the capabilities of a district for drainage either for agricultural purposes, or for collecting waters together for manufacturing power. They are superior to maps, as they show at a glance the relative heights of the various points, display the geological phenomena, and may be made to delineate the state of cultivation of the districts. The lines of railways, of roads, or of canals, can be more clearly defined upon them, and they are stated to be peculiarly adapted for parish surveys. The expense of making a model of an estate of compact form is stated to be from 2*s.* 6*d.* to 3*s.* 6*d.* per acre.

The following table will show the low rate of charge on minerals as compared with merchandize and passengers *per ton per mile*, the former nevertheless, from the regularity and magnitude of the business being the most profitable species of freight.

Liverpool and Manchester Railway, Passengers carried 31 miles, 50 ft. grade, 41 cents 4 mills, per ton per mile nett load, 6½ tons. Merchandize carried 31 miles, 50 ft. grade, 5 cents 7 mills, per ton per mile nett load 32 tons. Coals carried 15 miles level, 1 cent. 9 mills per ton per mile nett load 94 tons.—dividend 9 per cent.

Stockton and Darlington Railway, Coals carried 20 miles 50 ft. grade 2 cents per ton per mile nett load 63 tons.—dividend 15 per cent.

Philadelphia and Pottsville Railway, Coals 94 miles level 1 cent. 5 mills per ton per mile nett load 200 tons.—Just opened.

Durability of Wood Pavement.—The first wood pavement that was put down in London, at the east end of Oxford Street, four years since, is now being reversed and relaid, and causes much surprise by its great durability, many of the blocks not being reduced half an inch of their original length, which was one foot, though exposed to all the traffic of Oxford Street.